ITEM 70
RIPRAP

PART 1 – GENERAL

1.01 SCOPE

A. The work covered by this section includes furnishing all labor materials, and equipment required to furnish, place, and set rock riprap, concrete block riprap, and sacked sand-cement riprap as shown on the Drawings and/or specified herein.

B. Riprap shall be placed on slopes of embankments or other surfaces or around structures as protection against the erosive action of water.

C. Where shown on the Drawings, a filter blanket course of crushed rock, or sand and gravel, or an approved filter fabric shall be placed under the riprap.

1.02 SUBMITTALS

A. The CONTRACTOR shall provide the ENGINEER with written evidence in the form of mill test reports from a qualified testing laboratory that all sands, cements, and filter blanket materials used conform to the applicable requirements of this Specification section.

B. When requested by the ENGINEER, the CONTRACTOR shall furnish representative samples of rock riprap material for classification, gradation, or other tests as the ENGINEER may direct.

PART 2 – PRODUCTS

2.01 ROCK RIPRAP

A. Rock riprap shall be constructed using sound, dense, durable stones, or rock fragments, free from crack, pyrite intrusions and other structural defects. Stones which will be used with mortar shall be free from dirt, oil, or other material that might prevent good adhesion with the mortar. Stones with a laminated structure shall be avoided. Field stones shall not be used as a source of rock for riprap. Only rock that has been approved by the ENGINEER shall be used for riprap.

B. When the crushed aggregate is subjected to five (5) alternations of the sodium Sulfate soundness test, the weighted percentage of loss shall be not more than 12 percent.

C. Shape of the stones shall be generally rectangular or cubic. Flat or elongated stones having a small dimension less than 1/3 of the large dimension shall not be used.

D. At least 50 percent of the stones or rock fragments for plain rock riprap shall Weigh 150 pounds or more. The sizes of the stones shall be well graded from the smaller to the larger.

E. At least 90 percent of the stones or rock fragments for hand placed rock riprap shall weigh 100 pounds or more and shall be not less than 12 inches long, 12 inches deep, and 8 inches wide.

2.02 CONCRETE BLOCK RIPRAP

Concrete blocks for riprap shall be of the size as shown on the Drawings and shall be composed of non-reinforced Class A concrete conforming to the requirements of the section entitled "Cast-In-Place Concrete" of these Specifications..

2.03 SACKED SAND-CEMENT RIPRAP

A. Sand-cement for sacked sand-cement riprap shall be composed of a dry mixture of one bag (94 pounds) of cement to 5 cubic feet of dry sand.

B. Sacks shall be either cotton or jute, standard grade of cloth, which will hold the sand-cement mixture without leakage during handling and tamping. They shall be strong and shall be sized to hold approximately 1 cubic foot.

C. Cement shall be Type I Portland Cement conforming to ASTM C 150.

D. Sand shall be manufactured of natural siliceous river sand conforming to ASTM D 1073. The sand shall meet the following gradation requirements.

Sieve Size	Total Percent Passing by Weight
4	100
8	95-100
30	50-80
50	30-60
100	8-25
200	2-10

D. Sand shall be clean, hard, and free from excessive organic matter.

2.04 GROUT

A. Grout for grouted rock riprap shall be sand cement grout composed of one part Cement to four parts sand, measured by volume, mixed thoroughly with sufficient water to make a grout of such consistency that it will flow into and completely fill the voids.

B. Cement shall be Type I Portland Cement conforming to ASTM C 150.

C. Sand shall be cleaned, hard, natural siliceous sand conforming to the requirements of ASTM C 33 and the section entitled "Cast-In-Place Concrete" of these Specifications.

D. Water shall be fresh, clean, portable water free from injurious amounts of oil, acid, alkali, or organic matter.

2.05 FILTER BLANKET MATERIAL

A. Filter blanket material shall consist of fragments of sound, durable stone or crushed rock, free from disintegrated stone, alkali, salt, vegetable matter, or adherent coating. Aggregate shall be reasonably free from thin or elongated pieces. The percentage of wear of the aggregate as outlined AASHTO Test No. T-96 shall not exceed 7 percent.

B. Aggregate shall have the following gradation:

Sieve Size	Total Percent Passing by Weight
1-1/4”	100
1”	95-100
¾”	70-100
3/8”	50-85
No. 4	33-65
No. 10	20-45
No. 40	8-25
No. 200	0-10

C. The material finer than the No. 10 sieve shall be of such characteristics and gradation that will prevent the mass from setting up or becoming cemented together. Stone or crushed rock meeting the requirements of the section entitled “Mineral Aggregate Base” of these Specifications may be used provided the percentage fo aggregate passing the No. 100 sieve is less than 10 percent.

PART 3 – EXECUTION

3.01 EQUIPMENT

A. All equipment necessary for the satisfactory performance of the work shall be on hand and approved by the ENGINEER before construction will be permitted to begin.

B. The equipment shall include wooden or metal tamps of sufficient weight and number to properly compact the slopes on which the riprap or slope pavement is to be placed.

C. Wooden hand tamps, having a tamping face not greater than 1 square foot, and of sufficient weight and number to properly tamp the riprap, shall be furnished when sacked sand-cement is used.

D. Equipment for mixing cement grout or sand cement shall include a mechanical mixer or, if the ENGINEER approves hand mixing for cement grout, a watertight mixing platform or mixing box of adequate size.

3.02 PREPARATION OF FOUNDATION

A. Immediately prior to the construction of riprap, the slopes or ground surface shall be trimmed within reasonably close conformity to the lines and grades indicated on the Drawings or as directed by the ENGINEER, and shall be thoroughly compacted by the use of hand or mechanical tamps.

B. On slopes, the bottom of the riprap shall be placed at least 2 feet below the natural ground surface, unless otherwise shown or directed.

C. No material shall be placed on a frozen or otherwise unsuitable slope.

3.03 PLACEMENT OF FILTER BLANKET

A. Where shown on the Drawings, a filter blanket course shall be placed under the riprap on the prepared subgrade.

B. Filter blanket shall be placed immediately prior to placement of riprap. Compaction of the filter blanket is not required except where called for on the Drawings.

C. Where specifically permitted by the ENGINEER, a synthetic filter fabric may be substituted for the filter blanket course. Filter fabric shall be especially designed for use as slope stabilization under riprap and shall be acceptable to the ENGINEER. Placement of filter fabric shall be in strict conformance with the manufacturer's written instructions and recommendations.

3.04 MACHINE CONSTRUCTION OF PLAIN ROCK RIPRAP

A. Unless otherwise shown on specified, plain rock riprap shall be constructed using a crane and clam-shell or other suitable equipment approved by the ENGINEER. The rock shall be placed as nearly as practicable in final position using powered equipment. If necessary, larger rocks shall be worked up to the surface when the material on the surface does not meet the weight specification or when the voids next to the foundation material are too large.

B. The quantity of small stones shall be kept as low as possible, sufficient only to fill the voids between the larger stones. Care shall be taken that this small material is well distributed throughout the mass and not allowed to segregate or form pockets of small stone. All bridging shall be broken down. Large interstices, or open channels, or voids shall be filled by chinking or otherwise manipulating the stones.

C. When riprap is to be built on existing riprap, special care shall be taken to provide positive anchorage of the new riprap to the existing riprap.

D. The finished riprap surface shall in general conform to the slope lines shown on the Drawings. No objectionable, hazardous, or unsightly projections above the general place surface will be permitted.

3.05 CONSTRUCTION OF HAND PLACED, PLAIN ROCK RIPRAP

A. Hand placed plain rock riprap shall be constructed upon the prepared foundation by hand placing so that the stones shall be as close together as is practicable in order to reduce the voids to a minimum. Construction of riprap on sloped surfaces shall begin horizontal layers.

B. When rock riprap is constructed in more than one layer, it shall be so placed that it will be thoroughly tied together with the larger stones protruding from one layer into the other.

C. The standard depth of rock riprap shall be 12 inches unless otherwise indicated or directed and in no instance shall be less than 10 inches in depth. Rock riprap shall have an average depth for each 25 square feet of surface of not less than the depth indicated on the Drawings or directed by the ENGINEER, or the standard depth required in these Specifications.

D. Each stone shall be so placed that the depth will be perpendicular to the surface upon which it is set. The length shall be placed so that it will be against the adjoining stones. The stones shall be placed in such a manner as to stagger all joints as far as it is possible and practicable.

E. The main stones shall be thoroughly chinked and filled with the smaller stones by throwing them over the surface in any manner that is practicable for the smaller stones to fill the voids. This work shall continue with the progress of the construction. Tamping of the stones will not be required if the stones have been placed in a reasonable and satisfactory manner.

F. Knapping of the stones will not be required except stone protruding more than 4 inches above what is considered the normal surface of the stones, in which case these stone shall be broken down to come within 4 inches of the normal surface.

3.06 CONSTRUCTION OF GROUTED ROCK RIPRAP

A. Grouted rock riprap shall constructed upon the prepared foundation using hand placement and the stone shall be set or placed are close together as is practicable in order to reduce the voids to a minimum. Construction of riprap on slopes shall begin at the bottom and shall progress upward in approximately horizontal layers.

B. When rock riprap is constructed in layers, the layers shall be thoroughly tied together with large stones protruding from one layer into the other.

C. The standard depth of rock riprap shall be 12 inches, unless otherwise indicated or directed, and in no instance shall be less than 10 inches in depth. Rock riprap shall have an average depth for each 25 square feet of not less than the depth indicated on the Drawings or as directed by the ENGINEER, or the standard depth required in these Specifications.

D. Each stone shall be bedded with the depth perpendicular to the surface upon which it is set. The length shall be placed as directed by the ENGINEER and each main stone shall be placed against the adjoining stones with sides and ends in contact. The stone shall be placed in such a manner as to stagger all joints as far as it is possible.

E. After a workable area of the riprap has been set, the stones shall be knapped to a uniform surface and voids shall be thoroughly chinked and filled with smaller stones and spalls. This work shall continue with the progress of the construction.

F. The surface of the completed rock riprap shall not vary from the theoretical surface required by more than 2 inches at any point when tested with a 12-foot straightedge.

G. After chinking and filling, the voids between the stones shall be completely filled with grout. Care shall be take to prevent earth or sand from filling the spaces between the stones before the grout is poured.

H. This grout shall be mixed either in a one-bag mixer or larger, for not less than 1-1/2 minutes, or it may be mixed by hand in a watertight box of sufficient capacity to accommodate a batch of at least one bag of cement. Hand mixing shall be continued in a manner and for a period satisfactory to the ENGINEER.

I. Immediately before pouring the grout, the stones shall be wetted by sprinkling. The grout shall be carefully poured into the voids between the stones. This work shall begin at the lower portions of the riprap and progress upward. The entire bottom line of voids shall be filled with grout before the next line of voids above is poured. The pouring of the grout shall be accomplished by the use of vessels of adequate size and shape. Broadcasting, slopping, or spilling of grout from the vessels on the surface of the riprap will not be permitted. Progress of pouring shall be sufficiently slow to prevent the grout from oozing from the voids and flowing over the surface. During the pouring operations and continuing until the grout has assumed its initial set fiber brooms shall be used to maintain a uniform distribution over the entire surface. The grouting operations shall continue until such a time as all the voids have been completely filled and the grout has set even with the surface of the riprap.

J. As soon as any section of the grouted riprap has hardened sufficiently, it shall be cured by sprinkling with water until is has been covered with burlap, cotton or jute mats, earth or liquid-membrane forming compound. The mats or earth shall be maintained by soaking with water for a period of not less than 72 hours. The water used for wetting and curing the grouted riprap shall be free from salt or alkali.

30.7 CONSTRUCTION OF CONCRETE BLOCK RIPRAP

A. Concrete blocks for riprap shall be constructed to the dimensions shown on the Drawings and in accordance with the applicable provisions of the section entitled "Cast-In-Place Concrete" of these Specifications.

B. The concrete blocks shall be placed upon the prepared foundation by hand. Each block shall be bedded with the depth perpendicular to the surface upon which it is set, or placed and oriented as directed by the ENGINEER. Each block shall be placed against the adjoining blocks with sides and ends in contact. The blocks shall be placed in a manner that the joint will be staggered.

C. The surface of the completed concrete block riprap shall not vary from the desired theoretical plane by more than ½ inch for adjoining blocks and by more than 2 inches at any point when tested with a 12-foot straightedge.

3.08 CONSTRUCTION OF SACKED SAND-CEMENT RIPRAP

A. Sacked sand-cement riprap shall be constructed by placing sacks filled approximately ¾ full with a mixture of sand and cement on the prepared foundation. Sand and cement shall be mixed dry, with a mechanical mixer until the mixture is uniform in color. After the mixing has been completed, the sand-cement mixture shall be poured into sacks of approximately 1 cubic foot capacity until they are approximately ¾ filled. The sack shall then be securely fastened with hog rings by sewing or other suitable methods that prohibit leakage of the mixture from the bags.

B. The sacks of sand cement shall be bedded, by hand, on the prepared grade with all the fastened ends on the grade and with the joints broken. The completed riprap shall have a minimum thickness of 10 inches, measured perpendicular to the slope. The surface shall not vary more than 3 inches above or below the desired theoretical plane.

C. The sacks shall be rammed and packed against each other and tamped on the surface in such a manner as to form close contact and secure a uniform surface. Immediately after placing and tamping the sacks of sand cement, they shall be thoroughly soaked by sprinkling with water. Water shall not be applied under high pressure.

D. Sacks of sand cement ripped or broken in placing shall be removed and replaced before being soaked with water.

3.09 PROTECTION OF STRUCTURES

All structures shall be carefully protected from damage by equipment or impact of stones or blocks. All damage shall be corrected by the CONTRACTOR at his own expense and in a manner acceptable to the ENGINEER.